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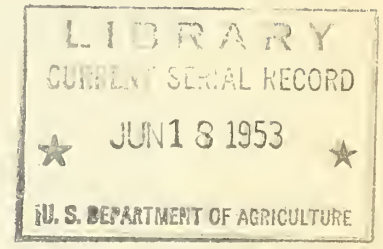
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X The Shelf Life of Lemons in Retail Store Display Cases X

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# THE SHELF LIFE OF LEMONS IN RETAIL STORE DISPLAY CASES

## INTRODUCTION

The purpose of this study was to determine the effects of various retail store display and handling methods upon the quality and condition of lemons. It was conducted in a laboratory at Beltsville, Md., equipped with several types of display cases in which retail store conditions could be simulated. Tests were conducted during each month of the year except June.

The lemons were displayed for 10 days as follows:

1. Continuously in a non-refrigerated case.
2. In a non-refrigerated case during the daytime and stored in 32° and 40° F. "walk-in coolers" at night.
3. On a false bottom and regular rack in a mechanically refrigerated case (convection type).
4. In an ice bed case.

A 6-foot wood display case with galvanized metal bottom and sides was used for non-refrigerated display. It was provided with a slatted rack sloping towards the front. The distance from the front to the back of the case was 30 inches. The top front edge was 10 inches above the bottom and the back was 32 inches high. The top extended 13 inches from the back toward the front.

A 10-foot commercial, mechanically refrigerated display case (convection type) with mirror back was used for one type of refrigerated display. The distance from the front to the back of the case was approximately 3 feet. The regular rack provided with the case was 3 inches above the bottom at the front and 5 inches above at the back. The top front edge of the case was 9 inches above the rack. To simulate retail store display methods in which the produce is elevated on a false bottom, a rack was constructed of quarter inch mesh wire screen at a level about 7 inches above the regular rack.

A 5-foot insulated commercial ice bed case with mirror back, metal sides and sloping bottom was the third type of case used. It measured approximately 27 inches from the front to the back and was 11 inches deep at the front and 8 inches deep at the back.

The display cases were in a room on the ground floor of a well insulated brick building.

A 32° and a 40° F. storage room were used for overnight storage of lemons displayed in the non-refrigerated case and for continuous storage for a 10 day period. Also a 55° room was used for continuous storage. The temperatures in these rooms were thermostatically controlled and small fans were used to provide air circulation.

The difference between the original weight of the lemons and the weight at the end of each testing period was recorded as "moisture" loss although it is recognized that a minor part of the loss was caused by respiration.



The lemons were examined for membranous stain by cutting through the center at right angles to a line running from the stem to the stylar end.

### Operation of the Display Room

All lemons used in the tests were obtained in original containers from the Washington, D. C. wholesale produce market. They were of 360 size.

At the laboratory, decayed lemons were discarded and the remainder sorted into representative samples for the tests. The lemons were placed on the racks 2 to 3 layers deep. Twenty to 50 lemons were used in each lot in various tests.

The lemons displayed in the mechanically refrigerated case and in the ice bed case were held in these cases night and day throughout the entire tests except for the time necessary each day to weigh and examine them for changes that may have occurred during the previous 24-hour period. The lemons in the cases were covered with heavy paper at night. Some lemons were not refrigerated at any time and remained in the non-refrigerated case throughout the tests. Other lots of lemons displayed in the non-refrigerated case during the daytime were stored at night in the "walk-in coolers" at 32° or 40° F. Some lemons were also stored continuously day and night for a period of 10 days in 32°, 40°, and 55° rooms with high humidity. All lemons were unwrapped and were 2 to 3 layers deep in open containers.

In each of the mechanically refrigerated and non-refrigerated cases, one lot was sprinkled with water several times daily and a duplicate lot was not sprinkled at any time. The non-sprinkled lemons that had been held overnight in refrigerated storages became wet from condensed moisture when they were returned to the non-refrigerated rack each morning.

In the ice bed case, the lemons were arranged on a bed of crushed ice which had been spread over the bottom of the case 3 to 5 inches deep. The ice bed was replenished once each day. One lot of lemons was covered with a thin layer of crushed ice each morning; and again at noon and mid-afternoon, and two lots were garnished with ice only at night when the lemons were prepared for night storage. One of these lots garnished with ice at night was sprinkled during the day and the other was not sprinkled but the lemons were wet in the morning from ice that melted during the night. At six o'clock at night a thick layer of ice was spread over the lemons in all lots in the ice bed case and they were then covered with heavy paper for the night.

The display period began between 8:00 A.M. and 9:00 A.M. when the lemons were placed on the racks and ended when they were prepared for night storage between 6:00 P.M. and 7:00 P.M.

The average daytime display room air temperature during each of the testing periods ranged from 75° during one test to 85° F. during another, averaging 78° for the 9 test periods. (Table 1).





The average relative humidity in the display room ranged from 34 percent during one test period to 70 percent in another, averaging 57 percent for the 9 test periods. (Table 1).

Fruit temperatures were obtained with thermocouples which were inserted into the lemons at the same relative positions on each of the display racks.

The relative humidity was recorded with a hygrothermograph.

Table 1. Temperatures and Relative Humidities in the Display Room and the Refrigerated Storage Rooms.

Test Period	Display Room				Storage Rooms		
	Temp.	Relative Humidity			Relative Humidity		
	°F.	Low %	High %	Avg %	32°Rm. %	40°Rm. %	55°Rm. %
Oct. 8 to 22, 1951	78	43	80	55	-	-	-
Feb. 11 to 20, 1952	75	50	60	54	-	-	-
Mar. 24 to Apr. 4, 1952	76	51	56	53	-	-	-
Apr. 29 to May 12, 1952	-	-	-	-	88	87	92
July 28 to Aug. 12, 1952	85	50	70	61	77	88	84
Aug. 12 to 22, 1952	82	55	74	65	84	84	87
Aug. 25 to Sept. 4, 1952	80	51	85	70	87	83	90
Nov. 3 to 14, 1952	78	26	43	34	88	85	93
Dec. 1 to 12, 1952	75	68	79	69	89	81	96
Jan. 5 to 16, 1953	<u>75</u>	53	62	<u>57</u>	<u>92</u>	<u>78</u>	<u>96</u>
Averages	78			57	86	84	92

### Results

The average 24-hour temperatures of lemons displayed in the non-refrigerated case during the daytime and held overnight in the 32° and 40° F. storage rooms were 26° and 21°, respectively, lower than lemons displayed continuously with no refrigeration. Lemons stored overnight in the 40° room after daytime display on the non-refrigerated rack averaged 52° for the 24-hour period, while those held at night in the 32° room averaged 47°. (Fig. 1).

Changes in lemon quality noted in these tests were loss of weight due to moisture loss, decrease in size, softening, drying of the skins, blackening or discoloration of "buttons", pitting of the skin, and membrane staining. (See table 2).

Pitting and membrane stain were of no importance in lemons held for 10 days under each of the various handling practices.

The development of decay was of little importance. Sprinkling with water several times daily caused no increase in decay, even at room temperatures.



Greatest deterioration occurred in lemons displayed continuously with no refrigeration, the non-sprinkled lemons becoming the most unattractive during the tests.

Lemons kept dry on the false bottom rack in the mechanically refrigerated case showed the second greatest deterioration.

Discoloration of the "buttons" usually progressed most rapidly in non-sprinkled lemons at the higher temperatures; the highest percentage of discolored buttons was found in the dry lemons that had not been refrigerated at any time.

Lemons that had been held at low temperatures remained attractive longer than those displayed continuously at high temperatures.

Sprinkling with water several times daily was beneficial under most methods of handling. No harmful effects due to sprinkling were found under any of the various handling practices.

Sprinkling had little effect upon lemon temperatures, the non-sprinkled lemons averaging only 1 to 2 degrees higher than the sprinkled.

Lemons stored continuously in the 32°, 40°, and 55° F. rooms for 10 days showed very little deterioration and remained attractive throughout the tests. An occasional lemon in the 40° room showed very slight membranous staining and a small percentage of decay developed in the 55° room. No pitting occurred on lemons stored at any of the above temperatures during the 10-day tests.

#### Suggestions for Prolonging the Shelf Life of Lemons

Lemons will retain a fresh attractive appearance for a longer period if refrigerated. Overnight storage in cold rooms is recommended if no equipment is available for daytime refrigeration. This suggestion does not conflict with recommendations given in U.S.D.A. Circular No. 278 which refers to much longer storage periods.

Lemons displayed continuously at room temperatures for a week or more frequently become excessively soft, the skins dry, and the lemons shrink in size and become unattractive.

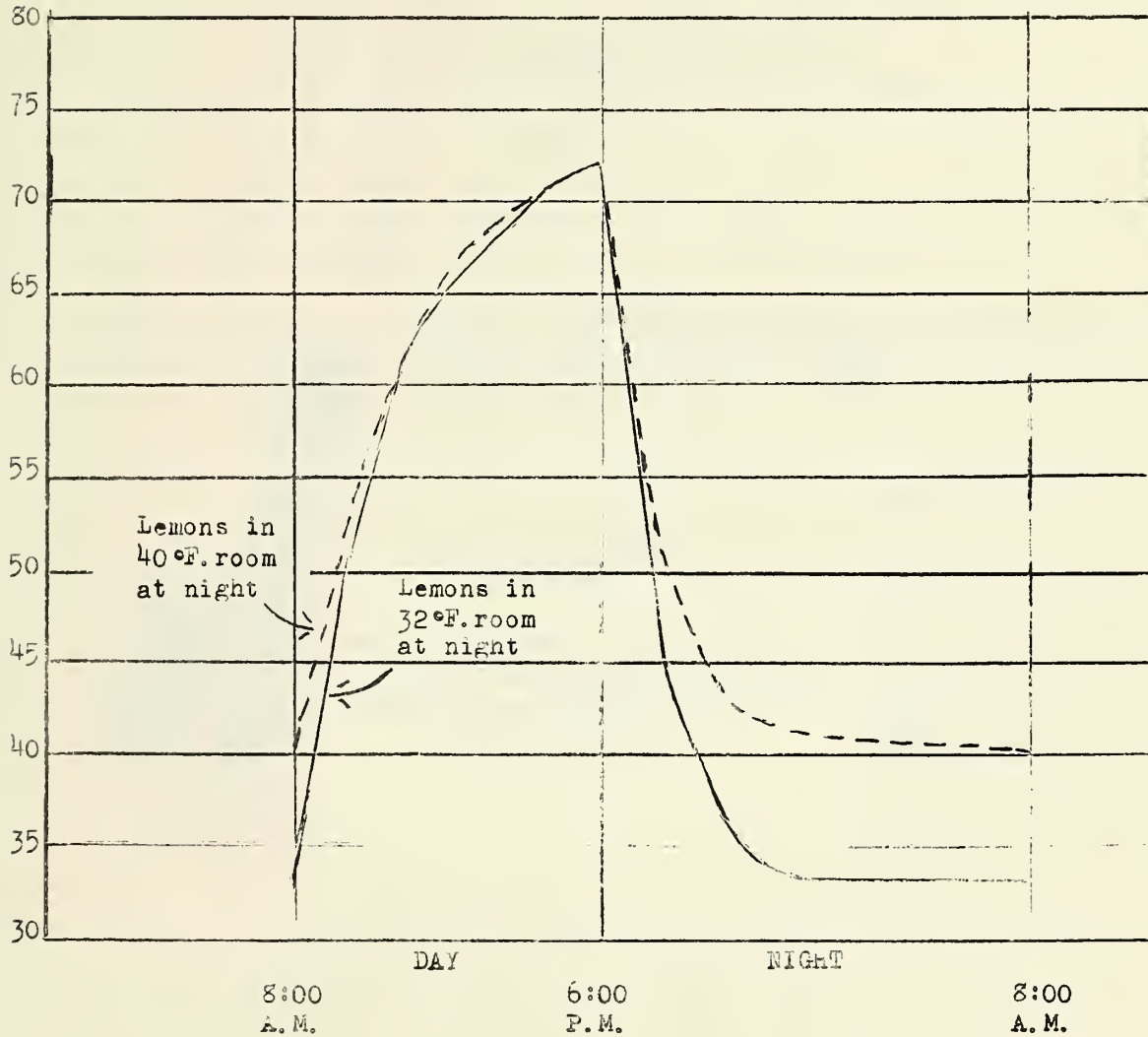
Black or discolored "buttons" increased most rapidly when lemons were displayed continuously at room temperatures.

Sprinkling with water several times daily had no harmful effect on the quality of the lemons and often proved beneficial. Sprinkling at the higher temperatures reduced weight and size losses that occurred in lemons that were kept dry.



Fig. 1. Temperatures of Lemons Displayed in a Non-refrigerated Case During the Daytime and While held at Night in a 32° and a 40° F. Storage Room.

°F.



Average 24-hour temperatures

- 78°F-Air in display room
- 73° -Lemons continuously with no refrigeration.
- 52° - " in 40° room at night-no refig. days.
- 47° - " " 32° " " " " " " " "

